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ORIGINAL

FLOOD INSURANCE STUDY

WAVE HEIGHT ANALYSIS

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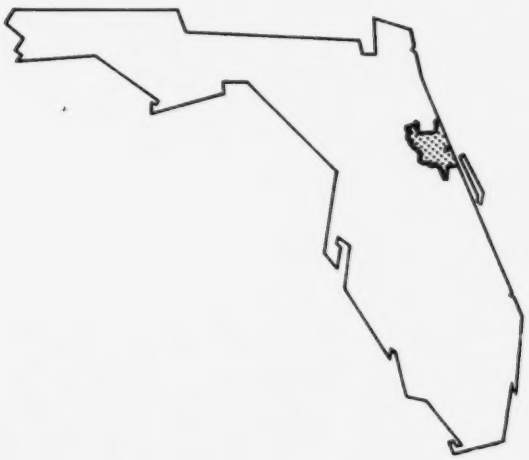

CITY OF NEW SMYRNA BEACH, FLORIDA
VOLUSIA COUNTY

MARCH 16, 1982

Federal Emergency Management Agency

COMMUNITY NUMBER-125132

ANALYSIS OF WAVE HEIGHTS
FOR
CITY OF NEW SMYRNA BEACH, VOLUSIA COUNTY, FLORIDA

FEDERAL EMERGENCY MANAGEMENT AGENCY

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TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
1.1	Background and Purpose	1
2.0	INVESTIGATIONS	2
2.1	Previous Studies	2
2.2	Data Collection and Review	2
2.3	Wave Height Analysis	3
2.4	Results	6
3.0	FLOOD PLAIN MANAGEMENT APPLICATIONS	8
3.1	Flood Boundaries	8
3.2	Base Flood Elevations	8
3.3	Velocity Zones	8
4.0	INSURANCE APPLICATION	9
4.1	Flood Hazard Factors	9
4.2	Flood Insurance Zones	9
4.3	Flood Insurance Rate Map	10
5.0	OTHER STUDIES	10
6.0	REFERENCES	10

FIGURES

Figure 1 - Transect Location Map 4

Figure 2 - Typical Transect Schematic 7

TABLES

Table 1 - Transect Locations, Stillwater Starting Elevations, and Maximum Wave Crest Elevations 5

Table 2 - Flood Insurance Zone Data 11

EXHIBITS

Exhibit 1 - Flood Insurance Rate Map Index
Flood Insurance Rate Map

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1.0 INTRODUCTION

1.1 Background and Purpose

The Federal Emergency Management Agency recently adopted recommendations by the National Academy of Sciences to include prediction of wave heights in Flood Insurance Studies for coastal communities subject to storm surge flooding, and to report the estimated wave crest elevations as the base flood elevations on Flood Insurance Rate Maps (FIRMs).

Previously, FIRMs were produced showing only the stillwater storm-surge elevations due to the lack of a suitable and generally applicable methodology for estimating the wave crest elevations associated with storm surges. These stillwater elevations were subsequently stipulated in community flood plain management ordinances as the minimum elevation of the first floor of new construction. Communities and individuals had to consider the additional hazards of velocity waters and wave action on an ad hoc basis. Because there has been a pronounced tendency for buildings to be constructed only to meet minimum standards, without consideration of the additional hazard due to wave height, increasing numbers of people could unknowingly be accepting a high degree of flood-related personal and property risk in coastal areas subject to wave action. Therefore, the Federal Emergency Management Agency has pursued the development of a suitable methodology for estimating the wave crest elevations associated with storm surges. The recent development of such a methodology by the National Academy of Sciences (Reference 1) has led to the adoption of wave crest elevations for use as the base flood elevations in coastal communities.

The City of New Smyrna Beach, which is located on the Atlantic coast, is subject to flooding from tidal surges that accompany hurricanes and other severe storms. Tidal flooding occurs along the open coast, at Ponce de Leon Inlet, and along mainland areas adjacent to the Indian River North/Intracoastal Waterway, Turnbull Bay, and Murray Creek.

Several hurricanes have caused flooding in and around New Smyrna Beach. The most severe were the storms of October 1944 and August-September 1964 (Hurricane Dora). Tide elevations of approximately 8 feet were experienced along the coast of Volusia County in both of these storms.

The purpose of this study is to revise the FIRM for the City of New Smyrna Beach to include the effects of wave action associated with flooding from the Atlantic Ocean at the open coast, of Ponce de Leon Inlet, and along the Indian River North/Intracoastal Waterway flood plain, Turnbull Bay, and Murray Creek.

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2.0 INVESTIGATIONS

2.1 Previous Studies

For the open coast of Volusia County, the stillwater elevation of a hurricane surge with a 100-year return period was determined by combining the results of two independent studies conducted by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers. The 10-, 50-, and 500-year storm-tide frequency return periods were determined by NOAA. The 100-year stillwater elevation was used as the base flood elevation for the coastal areas on the FIRM that is currently in effect for New Smyrna Beach (Reference 2).

The Indian River North/Intracoastal Waterway and Turnbull Bay storm tide-frequency relations were determined by NOAA, using empirical relations developed from historical data. The 100-year stillwater elevations were used as the base flood elevations on the FIRM for New Smyrna Beach.

A recent analysis of the tidal influx at Ponce de Leon Inlet indicates that the 100-year stillwater elevations for the Indian River North/Intracoastal Waterway should be reduced from 8 feet to 7 feet (Reference 3).

The stillwater elevations determined for these previous studies were used as the starting elevations for the wave height analysis presented herein.

This report is authoritative for purposes of the National Flood Insurance Program, and data presented herein supersede all previous flood elevation determinations.

2.2 Data Collection and Review

All available source data applicable for the wave height analysis were collected and reviewed. Because wave height calculations are based on such parameters as the size and density of vegetation, natural barriers (sand dunes), buildings, and other manmade structures, it was necessary to obtain detailed information on the physical and cultural features of the study area.

Officials of the City of New Smyrna Beach and Volusia County were contacted for maps and other possible data sources to be used in the analysis. In addition, the Florida Department of Natural Resources, Bureau of Beaches and Shores; the Florida Department of Transportation; the U.S. Army Corps of Engineers, Jacksonville District; and the National Oceanic and Atmospheric Administration, National Ocean Survey were contacted and all applicable data sources were obtained.

The principal source materials used for the wave height analysis are listed below.

a. Topographic data (ground elevations, seawall elevations, and locations of physical features) were determined using topographic maps at a scale of 1:1200, with a contour interval of 1 foot, prepared by Russell

& Axen (Reference 4); U.S. Geological Survey topographic maps at a scale of 1:24,000, with a contour interval of 5 feet (Reference 5); National Ocean Survey storm evacuation maps at a scale of 1:62,500, with a contour interval of 5 feet (Reference 6); topographic maps at a scale of 1:1200, with a contour interval of 2 feet (Reference 7), obtained from the Florida Department of Natural Resources; and beach profiles of the immediate Atlantic coast area also obtained from the Florida Department of Natural Resources (Reference 8).

b. Recent stereoscopic aerial photographs at a scale of 1:12,000 were used to determine vegetation parameters and to supplement the topographic maps for locations of physical features within Ponce de Leon Inlet (References 9 and 10).

2.3 Wave Height Analysis

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in the National Academy of Sciences report (Reference 1). This method is based on the following major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by procedures prescribed in Reference 1. The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Wave heights were computed along transects (cross section lines) in accordance with the Users Manual for Wave Height Analysis (Reference 11). The transects were located along the coastline as shown in Figure 1. They were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at larger intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

Each transect was taken perpendicular to the shoreline and extended to the inland limit of tidal flooding. Along each transect, wave heights and elevations were computed considering the combined effects of changes in ground elevation, vegetation, and physical features. The stillwater elevations for the 100-year flood were used as the starting elevations for these computations. Wave heights were calculated to the nearest 0.1 foot, and wave elevations were determined at whole-foot increments along the transects. The location of the 3-foot breaking wave for determining the terminus of the V Zone (area with velocity wave action) was also computed at each transect. Table 1 provides a listing of the transect locations and stillwater starting elevations, as well as initial wave crest elevations.

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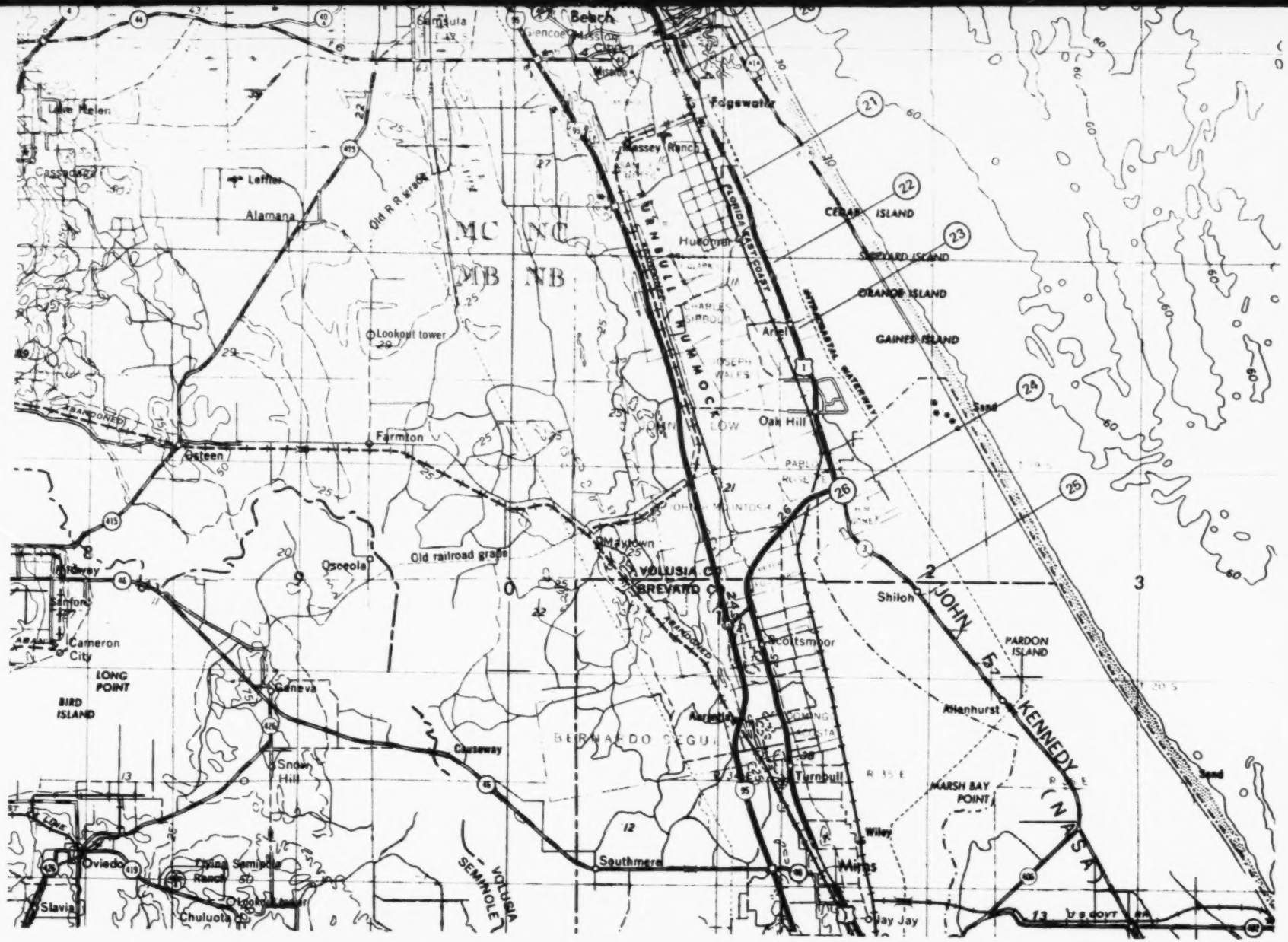

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FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUSIA COUNTY, FL

APPROXIMATE SCALE

4 0 4 8 12 MILES

TRANSECT LOCATION MAP

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Table 1.
Transect Locations, Stillwater Starting Elevations, and Maximum Wave Crest Elevations

Transect	Location	Elevation (Feet NGVD) Stillwater	Wave Crest
17	New Smyrna Beach - Through Ponce de Leon Inlet from the Atlantic Ocean westward across the Indian River North/ Intracoastal Waterway flood plain	8.0	12
18	New Smyrna Beach - Between Normandy Street and Due East Street from the Atlantic coastline westward across the Indian River North/Intracoastal Waterway flood plain	8.0	11
19	New Smyrna Beach - Between Oakwood Avenue and Ocean Avenue through the Indian River North/Intracoastal Waterway flood plain	8.0	11
20	New Smyrna Beach - Between East 11th Avenue and East 12th Avenue from the Atlantic coastline westward through the Indian River North/Intracoastal Waterway flood plain	8.0	11

Figure 2 is a profile for a typical transect illustrating the effects of energy dissipation and regeneration on a wave as it moves inland. This figure shows the wave elevations being decreased by obstructions, such as buildings, vegetation, and rising ground elevations, and being increased by open, unobstructed wind fetches. Actual wave conditions in New Smyrna Beach may not necessarily include all the situations illustrated in Figure 2.

After analyzing wave heights along each transect, wave elevations were interpolated between transects. Various source data were used in the interpolation, including topographic maps (References 4, 5, 6, and 7), beach profiles (Reference 8), aerial photographs (References 9 and 10), and engineering judgment. Controlling features affecting the elevations were identified and considered in relation to their positions at a particular transect and their variation between transects.

2.4 Results

Wave heights associated with the 100-year storm surge were found to have no significant flooding effect on the City of New Smyrna Beach. Areas on the open coast are protected by extensive, vegetated sand dunes that rise above the 100-year flood plain. These dunes are effective wave energy dissipators and are expected to remain intact during the 100-year storm. The maximum wave crest elevation at the ocean shoreline is 12 feet. Wave height elevations greater than 3 feet are diminished near the shoreline by the rising slope of the beach and the sand dunes. The inland boundary of the beach approximates the extent of flooding along the open coast.

The crest elevations of the jetties at Ponce de Leon Inlet were too low to have any significant effect on wave heights from the ocean. Wave crest elevations of 12 feet will occur inside the inlet.

Within the Indian River North/Intracoastal Waterway flood plain, the vegetation and dredge spoils were considered to maintain their height and density during the 100-year storm. Wave heights of 1 foot are generated over the Indian River North/Intracoastal Waterway flood plain. On the leeward side of the river, the 1-foot wave height is diminished by dredge spoils, then regenerates over the lowlands cut by Smyrna and Hunter Creeks. This 1-foot wave is stopped abruptly by a steep bank at the leeward edge of the flood plain.

Although a 1-foot wave height is generated on the Indian River North/Intracoastal Waterway flood plain, no wave heights are generated in the developed areas in the vicinity of North Causeway and Harris Saxon Bridge. The 1-foot wave height generated south of Harris Saxon Bridge is diminished by vegetation and a rising ground slope.

The Turnbull Bay and Murray Creek flood plains are inundated by tidal flooding, but due to vegetation and high ground elevations, they are not affected by wave action.

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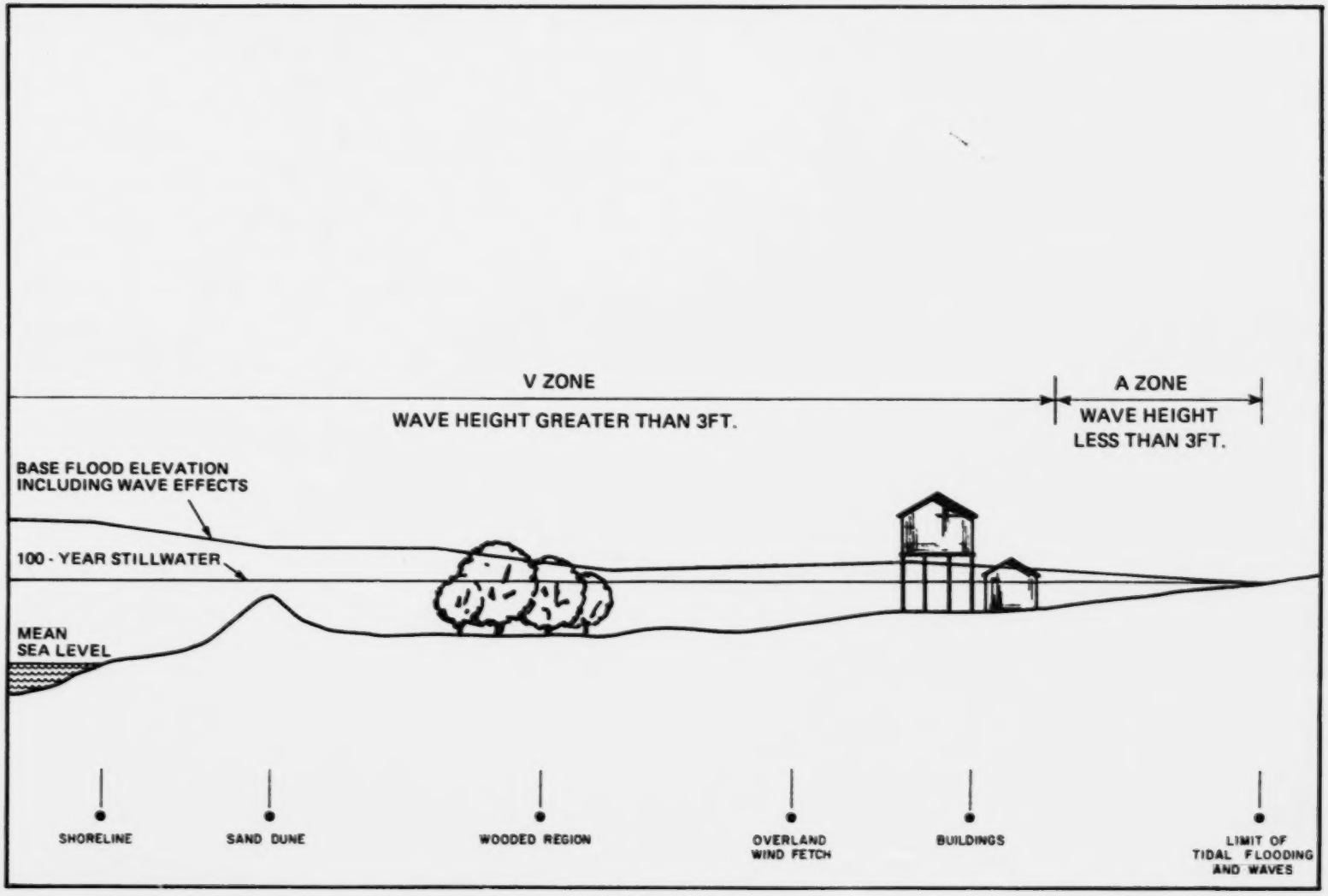

FIGURE 2
TYPICAL TRANSECT SCHEMATIC

3.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage local governments to adopt sound flood plain management programs designed to reduce future flood losses. The FIRM for New Smyrna Beach has been revised to incorporate the latest available information, including wave height data, to assist these communities in developing the most appropriate and effective flood plain management measures.

3.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Emergency Management Agency as the base flood for purposes of flood plain management. This flood has a 1 percent chance of being equalled or exceeded each year and is expected to be exceeded once on the average during any 100-year period. The risk of having a flood of this magnitude or greater increases when periods longer than 1 year are considered. For example, over a 30-year period, there is a 26 percent chance of experiencing a flood equal to or greater than the 100-year flood. The 500-year flood plain is also shown on the FIRM to indicate areas of moderate flood hazards.

Areas inundated by the 100-year flood are shown as A and V Zones on the community's FIRM. It is in these areas that the Federal Emergency Management Agency requires local communities to exercise flood plain management measures as a condition for participation in the National Flood Insurance Program.

3.2 Base Flood Elevations

Areas within the communities studied by detailed engineering methods have base flood elevations established in A and V Zones. These are the elevations of the base (100-year) flood relative to the National Geodetic Vertical Datum of 1929. In coastal areas affected by wave action, base flood elevations are generally maximum at the open coast shoreline. These elevations generally decrease in a landward direction at a rate dependent on the presence of obstructions capable of dissipating the wave energy. Where possible, changes in base flood elevations have been shown in 1-foot increments on the FIRMs. However, where the scale did not permit, 2- or 3-foot increments were sometimes used. Base flood elevations shown in the wave action areas represent the average elevation within the zone. Current program regulations generally require that all new construction be elevated such that the first floor, including basement, is above the base flood elevation in A and V Zones.

3.3 Velocity Zones

The U.S. Army Corps of Engineers (Reference 12) has established the 3-foot breaking wave as the criterion for identifying coastal high hazard zones. This was based on a study of wave action effects on structures. This criterion has been adopted by the Federal Emergency Management Agency for the determination of V Zones. Because of the additional hazards associated with high-energy waves, the National Flood Insurance Program regulations require much more stringent flood plain management measures in these areas, such as elevating structures on piles or piers. In addition, insurance rates in V Zones are higher than those in A Zones with similar numerical designations.

The location of the V Zone is determined by the 3-foot breaking wave as discussed previously. The detailed analysis of wave heights performed in this study allowed a much more accurate location of the V Zone to be established. The V Zone generally extends inland to the point where the 100-year flood depth is insufficient to support a 3-foot breaking wave.

4.0 INSURANCE APPLICATION

The assignment of proper actuarial insurance rates requires that frequency and depth of flooding be estimated as accurately as possible. Because waves can add considerably to expected flood depths, it is important that insurance rates consider this additional hazard. The Federal Emergency Management Agency has developed a process to transform the data from this study into flood insurance criteria. This process includes the determination of Flood Hazard Factors and the designation of flood insurance zones.

4.1 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHF are used to set actuarial insurance premium rate tables.

The FHF is shown as a three-digit code that expresses the difference between the 10- and 100-year flood elevations to the nearest 0.5 foot. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, the FHF is computed to the nearest foot.

4.2 Flood Insurance Zones

After wave elevations for the 100-year storm surge were determined and mapped, the study areas were divided into zones, each having a specific flood potential and FHF. Each zone was assigned one of the following flood insurance zone designations:

Zone V7:	Special Flood Hazard Areas inundated by the 100-year flood, and that have additional hazards due to velocity (wave action); base flood elevations shown, and zones subdivided according to FHFs.
Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.

Zones A5 and A7:	Special Flood Hazard Areas inundated by the 100-year flood, with base flood elevations determined and zone designations assigned according to the FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood plain, including areas that are protected from the 100- and 500-year floods by dike, levee, or other water control structure; and areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot, or where the contributing drainage area is less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas not subject to flooding by the 500-year flood. Zone C is not subdivided.

Table 2, "Flood Insurance Zone Data," summarizes the FHFs, flood insurance zones, and base flood elevations for each flooding source in the study area.

4.3 Flood Insurance Rate Map

After flood insurance zones were established for the study area, the FIRM for New Smyrna Beach was revised to incorporate the new zone information. This map (Exhibit 1) contains the official delineation of flood insurance zones and base flood elevations.

In revising the FIRM, the Atlantic Ocean shoreline and some zone boundaries in areas not affected by the wave height analysis were revised to reflect updated topographic information. Revisions to corporate limits and cultural features were made using a current community map (Reference 13).

5.0 OTHER STUDIES

Flood Insurance Rate Maps for the adjacent Town of Ponce Inlet and the unincorporated areas of Volusia County are being revised concurrently with the City of New Smyrna Beach to include wave height analysis. The revised studies for Ponce Inlet and Volusia County will be in agreement with this study.

The FIRM for the adjacent City of Edgewater (Reference 14) is not being revised at this time to incorporate the results of the tidal influx analysis or wave height analysis; therefore, it will not agree with this study.

6.0 REFERENCES

1. National Academy of Sciences, Methodology for Calculating Wave Action Effects Associated with Storm Surges, 1977

Table 2. Flood Insurance Zone Data

Flooding Source	Stillwater Elevation 10-Year	50-Year	100-Year	500-Year	FHF	Zone	Base Flood Elevation (Feet NGVD)*
Atlantic Ocean Open Coast/ Ponce de Leon Inlet	5.7	7.2	8.0	10.8	035	V7	10 to 12
					035	A7	8 to 10
Indian River North/Intracoastal Waterway and Turnbull Bay	4.7	6.2	7.0	9.8	035	A7	7 to 9
Turnbull Creek	3.7	5.2	6.0	8.8	025	A5	6
Murray Creek and Indian River North/ Intracoastal Waterway	4.7	6.2	7.0	9.8	025	A5	7

*Due to map scale limitations, base flood elevations shown on the FIRM may represent average elevations for the zones depicted.

2. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Insurance Rate Map, City of New Smyrna Beach, Florida, 1979

3. Federal Emergency Management Agency, Review of Port Orange, Florida 1916 (Part 66) Appeal, Century Engineering, Inc., July 1980

4. Russell & Axon, Topographic Maps, Scale 1:1,200, Contour Interval 1 foot: New Smyrna Beach, Florida (1961)

5. U.S. Department of the Interior, Geological Survey, 7.5-Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 feet: New Smyrna Beach, Florida (1956), Photorevised (1970); Edgewater, Florida (1950), Photorevised (1970); Ariel, Florida (1950), Photorevised (1970)

6. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey, Storm Evacuation Map T-15076, Scale 1:62,500, Contour Interval 5 feet: New Smyrna Beach, Florida (1977)

7. Florida Department of Natural Resources, Bureau of Beaches and Shores, Volusia County Coastal Construction Control Line, Preliminary, Scale 1:1,200, Contour Interval 2 feet, Photographed 1978

8. Florida Department of Natural Resources, Bureau of Beaches and Shores, Volusia County Beach Profiles, Scale 1:600, 1972

9. Federal Emergency Management Agency, Stereoscopic Aerial Photographs of Volusia County, Florida, Scale 1:12,000, January 1981

10. Florida Department of Transportation, Stereoscopic Aerial Photographs of Volusia County, Florida, Scale 1:12,000, August 1978

11. Federal Emergency Management Agency, Users Manual for Wave Height Analysis, Revised February 1981

12. U.S. Army Corps of Engineers, Galveston District, Guidelines for Identifying Coastal High Hazard Zones, June 1975

13. Volusia Council of Governments, New Smyrna Beach, Florida, Community Map, Scale 1:9600, October 1980

14. Federal Emergency Management Agency, Flood Insurance Rate Map, City of Edgewater, Florida, 1980